

Human Tissue Reaction to Sutures

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Tissue reaction to sutures was studied in 666 specimens obtained from patients from one day to 23 years after operation. Reaction to catgut depends on the stage of absorption and is mainly histocytic in type. Nonabsorbable sutures are encapsulated by a rim of connective tissue, while near the suture histocytes, giant cells and lymphocytes are found. This is most marked with silk and cotton, less so with Dacron, and least with nylon and wire. Tissue infiltration into the suture interstices is variable. The reactions resemble the findings in experimental animals.

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A NUMBER of reports¹⁻⁹ have described the tissue reaction to sutures in experimental animals, but to our knowledge, no systematic study of these reactions in humans has been performed. We believe such a study is of interest of itself and also to aid in interpretation of animal investigations as applicable to patients.

Methods

The material was obtained at a second operation on patients or at autopsy. A small block of tissue to include at least part of the suture was removed, fixed and stained with hematoxylin and eosin. Considerable care was taken in orienting the tissue so that a cross section of the suture and adjacent tissue would be secured.

The microscopic findings were first described by one of us. Independently, another one of the authors graded the tissue response to the suture, on a scale of 0 to 4, for tissue infiltration into the suture strands and the approximate number of the following cells: neutrophils, lymphocytes, fibroblasts, histiocytes, and giant cells. As shown in Table 1, 14% of the 666 specimens were not satisfactory for grading. In a number of instances, this was due to hemorrhage or infection in the area of the suture. Wire was, of course, removed from the tissue before sections were cut, and grading was done only when the site of the wire could be identified unequivocally.

The number of sutures of each type is shown in Table 1 and the interval the suture had been in the tissue in Table 2. The longest intervals, in years, for each suture was catgut 11, silk 23, cotton 7, wire 33, nylon 10, Dacron 11, and Dacron coated with Teflon 6. Sutures were obtained from a wide range of sites in the body but 80% came from muscle, fascia, or skin.

Tissue Reaction

The initial reaction of the tissues is a reflection of the amount of injury inflicted by passage of the needle and suture. Assuming the same technique, tissue, and other reactive factors such as absence of infection, the reaction will be the same for all sutures during the first five to seven days, if not longer. The following descriptions, therefore, concern the chronic rather than the acute response of tissues to sutures.

Catgut

After the initial reaction subsides, catgut appears the same as any monofilament suture with a thin connective tissue capsule, a few histiocytes and lymphocytes. The reaction is altered when absorption begins, the time of absorption being variable. The absorbing cells may remain primarily at the periphery of the suture or clefts may appear in the catgut into which the cells infiltrate. The cells are almost exclusively monocytic with a few lymphocytes and few or no polymorphonuclear neutrophils. Capillary formation is variable and no eosinophilic reaction is seen as occurs occasionally in animals. After absorption is complete, the site is marked by a collection of monocytes with characteristic brown, foamy cytoplasm.

A wide range of apparent biologic variation exists in the time of absorption as demonstrated by the catgut sutures removed, one at eight and the second after 11 years.

Submitted for publication April 3, 1974.

Supported in part by Ethicon, Incorporated.

TABLE 1. *Human Tissue Reaction to Sutures: Source of Material*

	Surgical	Sutures Graded Autopsy	Total	Not Graded	Total
Catgut	12	16	38	18	46
Silk	224	116	340	50	390
Cotton	2	2	4	0	4
Wire	13	2	15	22	37
Nylon	39	54	93	17	110
Dacron	23	11	34	7	41
Dacron-T	27	10	37	1	38
Total	340	211	551	115	666

Both were surrounded by a connective tissue capsule with no evidence of absorption.

Silk

The reactions to silk may be divided into two major types. In the first and most frequent, the suture remains compact and is surrounded by a fibrous tissue capsule of variable thickness. Within the capsule adjacent to the suture a layer of histiocytes is seen, usually from one to three cell layers deep. Giant cells vary in both occurrence and numbers. Lymphocytes also vary and occasionally occur as focal accumulations. In the more cellular reactions, capillaries may be prominent. In the second type of reaction, the capsule is present but the interstices of the suture are invaded by fibroblasts and histiocytes. In rare instances, the reaction appears much like a granuloma.

From clinical experience, silk is known to be absorbed and evidence of this was found in this study. A few sections were seen in which only four or five strands of silk remained, the site characteristically showing a fairly brisk monocytic reaction. Another point of interest was those situations in which a loop of suture could be reasonably well identified. On the side of the suture toward the tension, acellular fibrous tissue was present while the cellular reaction was opposite the direction of tension.

Cotton

Only a few specimens of cotton were obtained. The reaction was quite similar to silk but somewhat more cellular.

TABLE 2. *Interval Graded Sutures in Tissues*

	<1 Year	1-5 Years	6-10 Years	>10 Years
Catcut	26	0	1	1
Silk	199	103	24	14
Cotton	1	2	1	0
Wire	7	4	2	2
Nylon	78	13	2	0
Dacron	24	7	2	1
Dacron-T	25	8	4	0
Total	360	137	35	19

Wire

The spaces left by wire are surrounded by a fibrous tissue capsule, all or a part of which is lined by monocytic cells. The reaction is considerably less than silk. The spaces tend to be oblong or eccentric, suggesting a cutting action.

Nylon

The tissue reaction to nylon is the least of all sutures examined. All specimens contained the monofilament type, and this is surrounded by a narrow, compact fibrous tissue zone. Histiocytes adjacent to the suture occur occasionally; giant cells rarely. No fragmentation of the suture is seen.

Dacron

The tissue reaction to this material is very similar to that seen to silk except overall the reaction is considerably less. The suture usually remains compact, the fibrous tissue capsule is lined by histiocytes, and giant cells may be present. Invasion between the suture strands does occur and this is more likely to develop after longer periods of implantation.

Dacron Coated with Teflon

This material elicits a response similar to Dacron with the additional reaction due to what apparently is Teflon shed off the Dacron. In the sections, this brownish amorphous material may remain in or near the suture, stimulating a greater cellular response. In a number of specimens, however, the Teflon is seen as scattered granules in the vicinity of the suture, each particle being surrounded by its own histiocytic and giant cell reaction.

FIG. 1. (Overleaf, from left to right and above down) *G10D*, Gut 10 days, gastroenterostomy. Essentially no reaction. *G19D*, Gut 19 days, subcutaneous. Absorption beginning, mainly by monocytes. Serrations at edges and one cleft in suture. *G20D*, Gut 20 days, subcutaneous. No absorption; fibrous capsule and little cellular response. *G42D*, Gut 42 days, fascia. Fragmentation of suture with monocytic reaction. *G1Y*, Gut one year, fascia. Brown, foamy remnants in cells. *G11Y*, Gut 11 years, vaginal cuff closure. No absorption or reaction. *S55D*, Silk 55 days, chest wall. Two characteristic reactions in same patient. *S55D*, Fibrous capsule with moderate cellular reaction around compact suture. *S55D*, Tissue infiltration among silk fibers. *S82D*, Silk 82 days, esophagogastric anastomosis. Part of loop: acellular fibrous tissue at top in direction of tension. *S3Y*, Silk 3 years, joint capsule. Probably a knot. Fibers of silk scattered throughout tissue with granulomatous appearance. *S6Y*, Silk 6 years, fascia. Number of fibers indicates absorption. *S6Y*, Silk 6 years chest wall. Thick fibrous capsule; monocytes near suture. *S12Y*, Silk 12 years, abdominal wall. Mature capsule but still some cellular reaction. *S20Y*, Silk 20 years, fascia. Thick capsule, fairly cellular with monocytes and giant cells near suture. *C2Y*, Cotton 2 years, fascia. Reaction at opposite poles. (Low power $\times 40$; high power $\times 100$)



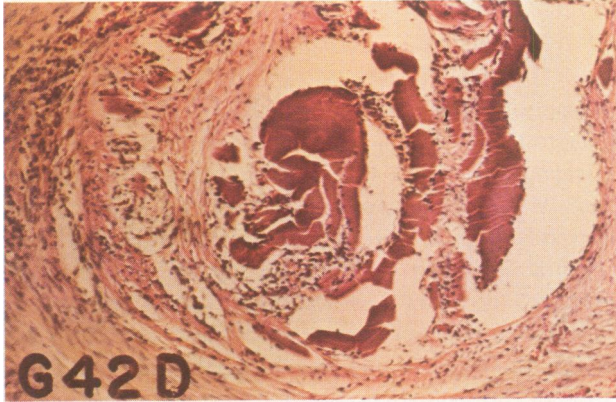
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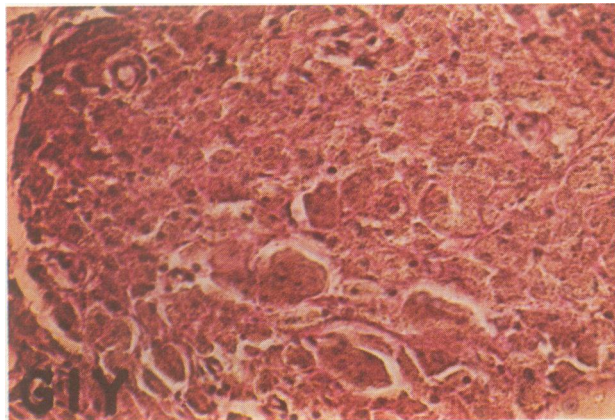
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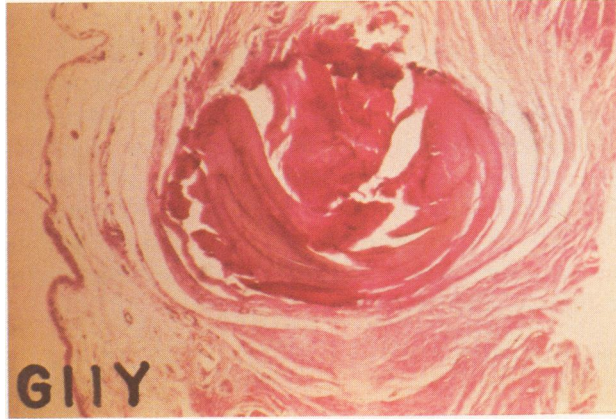
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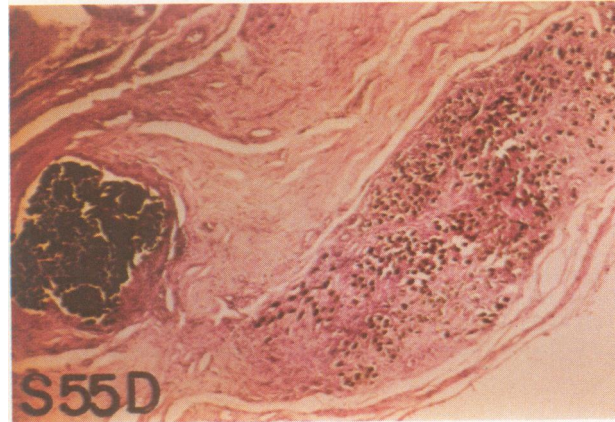
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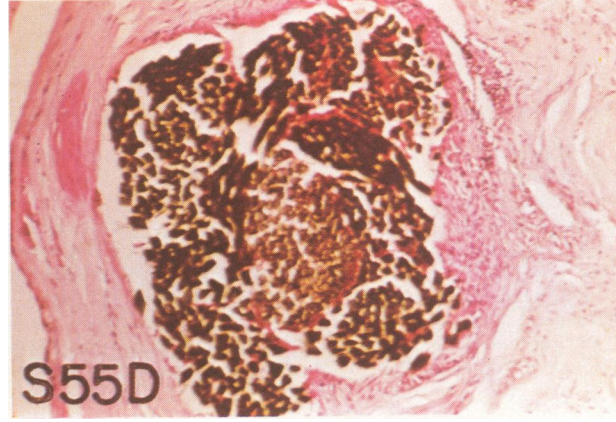
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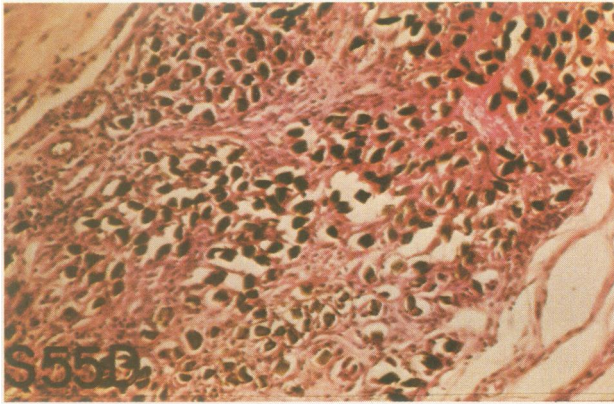
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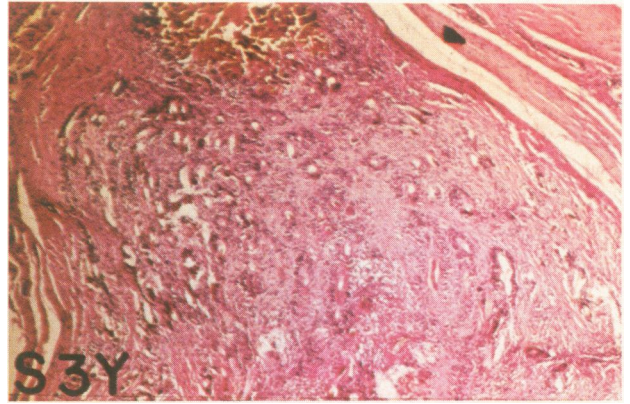
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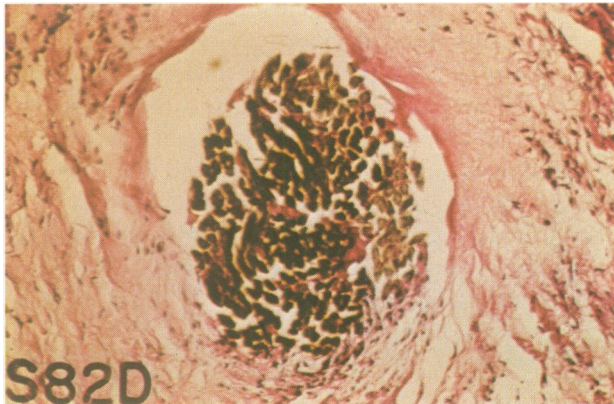
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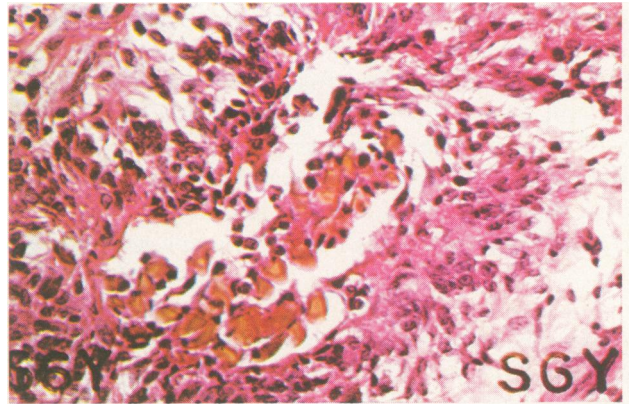
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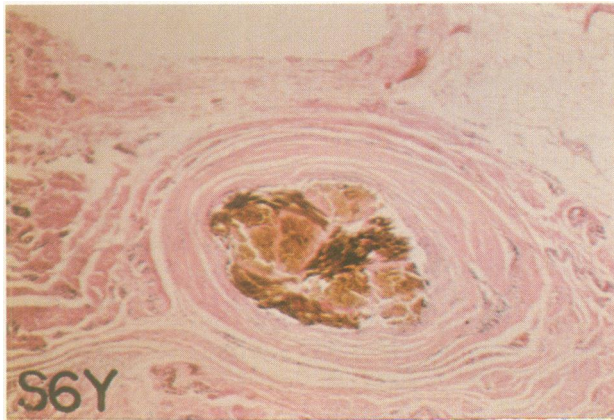
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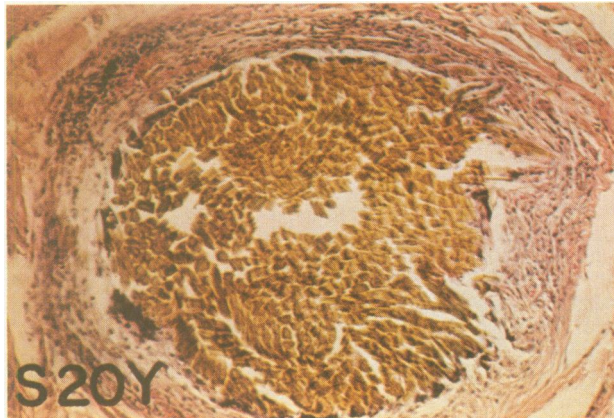
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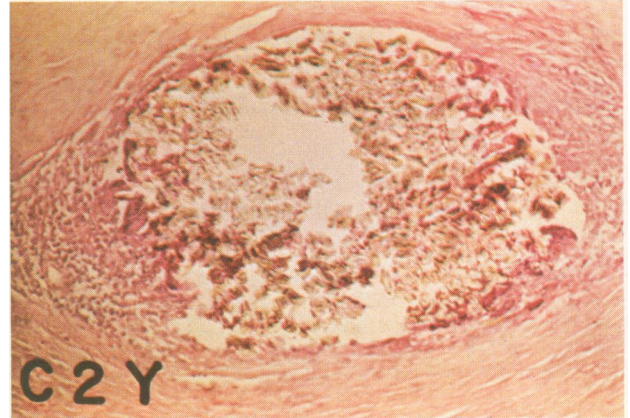
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TABLE 3. *Grades of Tissue Reaction*

	No. Sutures	Neutro- philes	Lympho- cytes	Fibro- blasts	Histio- cytes	Giant Cells	Invasion Suture
Silk 3 wks.-1 Yr.	110	0.16	1.0	2.3	2.0	0.9	0.9
Silk >1 Yr.	141	0.12	0.8	2.6	2.0	0.9	0.8
Nylon >1 Yr.	15	0.0	0.6	1.1	0.4	0.1	0.0
Dacron >1 Yr.	10	0.0	0.8	2.0	1.6	1.2	1.2

Miscellaneous

Suture specimens were obtained from 12 renal transplant patients. All were receiving azathioprine and, most of them, steroids. Catgut, silk, nylon and Dacron were examined. The transplant had been less than 30 days earlier in four patients and ranged from two months to five years in the others. The remarkable finding was the very limited response, either fibroblastic or histiocytic, to the sutures. Actually, in some sections the suture appeared to have displaced adjacent normal tissue without any cellular response.

Discussion

In previously reported animal studies of tissue reaction to sutures, one of us^{8,9} has utilized a system of grading the reaction entailing the size of the reaction zone, the type of reactive cells, and an estimate of their number. Although a numerical grade is then obtained, the grading process is tedious and the grade of value only for comparison. In the present study, a less detailed system of grading was used and no exhaustive analysis was made of the results. Grading, however, is useful as illustrated by Table 3. The reaction to silk in place from three weeks to one year is compared to silk in tissue over a year. The grades indicate that little change occurs with time for the silk sutures examined. Comparing silk with nylon and Dacron indicates the least reaction is seen to nylon, a more intense reaction to Dacron, and still greater reaction to silk.

The tissue reaction to sutures has been reported in detail in the rat, rabbit, and dog. The reaction in rats to various sutures appears to be more severe than that in the rabbit or dog.^{3,4} Our work previously has been almost exclusively with rabbits. Although a precise comparison cannot be

made, the reaction in humans generally is similar to but less intense than that seen in experimental animals. Transfer of the findings in animal studies would, therefore, appear to be acceptable with only moderate limitations.

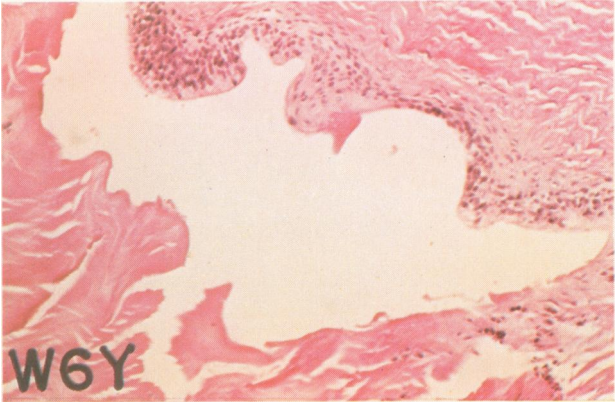
Unfortunately, the specimens available did not include some of the more recently developed sutures, both absorbable and nonabsorbable. Reports of animal studies concerning these are available, however, and it is apparent that the ideal suture remains to be found.

Parenthetically, in spite of the long exposure to suture material in some of the patients, no evidence of neoplasia was seen in any section.

References

1. Dettinger, G. B. and Bowers, W. E.: Tissue Response to Orlon and Dacron Sutures. A Comparison with Nylon, Cotton, and Silk. *Surgery*, **42**:325, 1957.
2. Jenkins, H. P., Hrdina, L. A., Owens, F. M., Jr. and Swisher, F. M.: Absorption of Surgical Gut (Catgut) III. Duration in the Tissues After Loss of Tensile Strength. *Arch. Surg.*, **45**:74, 1942.
3. Lawrie, P., Angus, G. E. and Reese, A. J. M.: The Absorption of Surgical Catgut. *Br. J. Surg.*, **46**:638, 1959.
4. Lawrie, P., Angus, G. E. and Reese, A. J. M.: The Absorption of Surgical Catgut. II. The Influence of Size. *Br. J. Surg.*, **47**:551, 1960.
5. Madsen, E. T.: An Experimental and Clinical Evaluation of Surgical Suture Materials—I. *Surg. Gynecol. Obstet.*, **97**:73, 1953.
6. Madsen, E. T.: An Experimental and Clinical Evaluation of Surgical Suture Materials—II. *Surg. Gynecol. Obstet.*, **97**:439, 1953.
7. Madsen, E. T.: An Experimental and Clinical Evaluation of Surgical Suture Materials—III. *Surg. Gynecol. Obstet.*, **106**:216, 1958.
8. Postlethwait, R. W., Schauble, J. F., Dillon, M. L. and Morgan, J.: Wound Healing. II. An Evaluation of Surgical Suture Material. *Surg. Gynecol. Obstet.*, **108**:555, 1959.
9. Postlethwait, R. W., Dillon, M. L. and Reeves, J. W.: Experimental Study of Silk Suture. *Arch. Surg.*, **84**:698, 1962.

FIG. 2. (Opposite and overleaf, from left to right and above down.) W6Y, Wire 6 years, fascia. Very moderate cellular reaction along one side. W8Y, Wire 8 years, fascia. Fibrous capsule with flat monocytes lining. N10D, Nylon 10 days, subcutaneous. No reaction. N2Y, Nylon 2 years, tendon. Unusual uniform lining of monocytes. N10Y, Nylon 10 years, fascia. Essentially no reaction. Note physical change in staining of suture. D7M, Dacron 7 months, chest wall. Fibrous capsule with monocytes near suture. D40M, Dacron 40 months, fascia. Fairly thin capsule; cellular reaction persists with few giant cells. D11Y, Dacron 11 years. Still encapsulated but septa of fibrous tissue. Note giant cells. T3M, Teflon coated Dacron 3 months, fascia. Cellular reaction in part due to shed Teflon. T55W, Teflon coated Dacron 55 weeks, subcutaneous. Dark cellular areas away from suture surround brownish amorphous material thought to be Teflon. T55W, Higher power of previous section. Note area of reaction in left upper corner. T6Y, Teflon coated Dacron 6 years, fascia. Shed Teflon persists in and near suture. D22D(TR), Dacron 22 days, kidney transplant. No reaction. S12D, Three sections of silk 12 days, skin. Epithelial down growth along suture; note keratin formation.



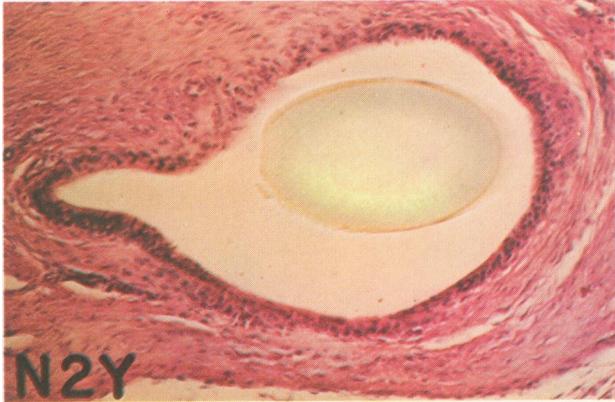
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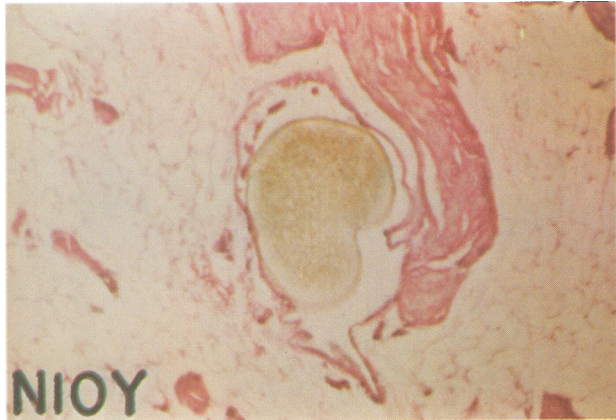
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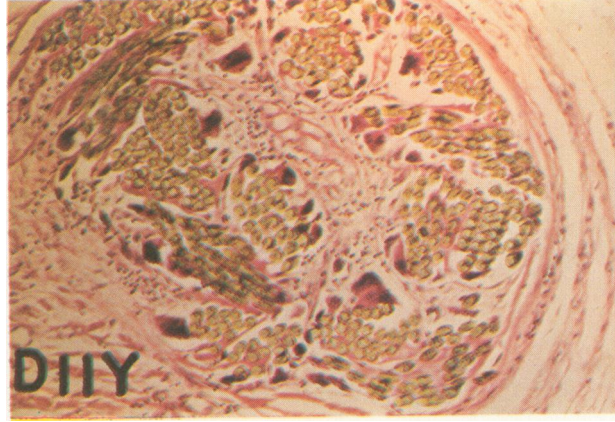
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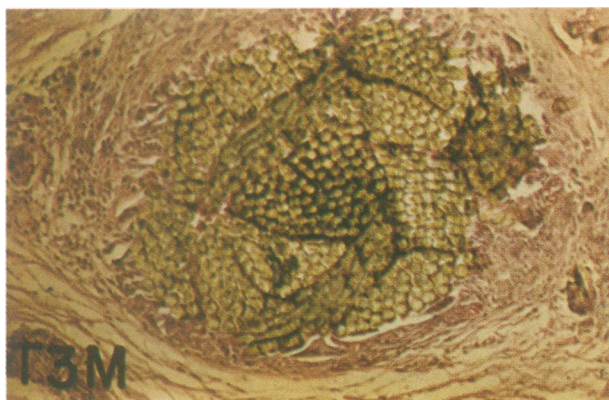
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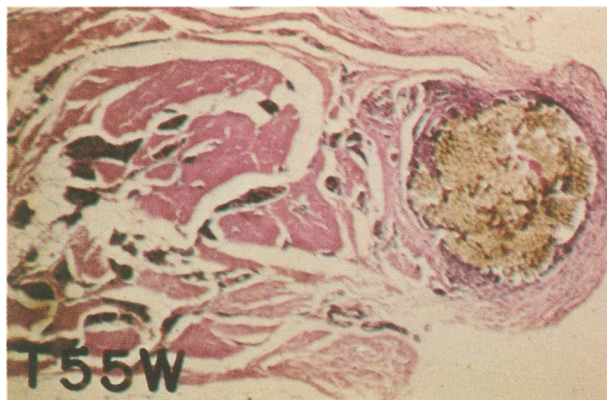
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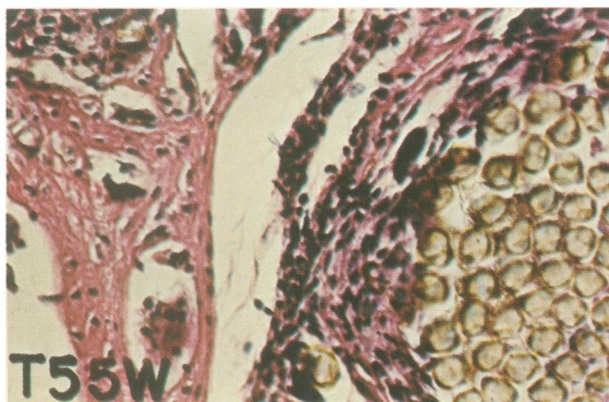
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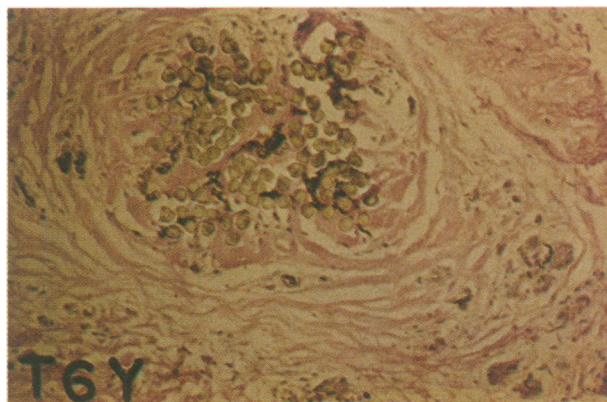
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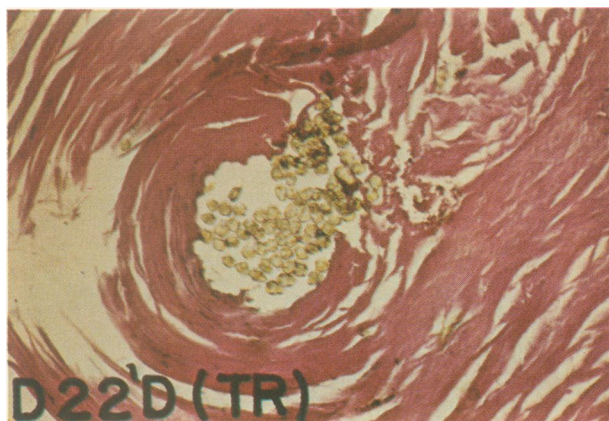
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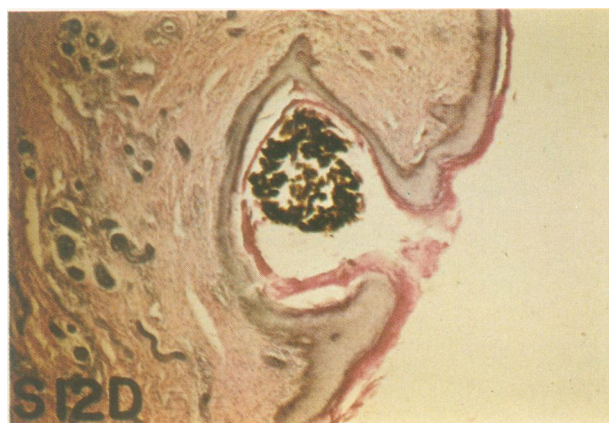
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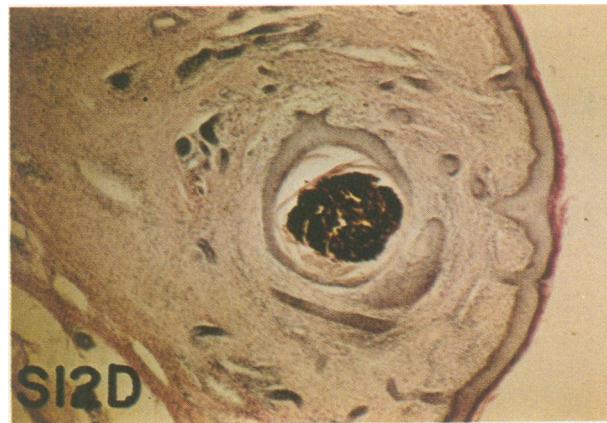
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